Stability of magnesium based nanoparticles for hydrogen storage

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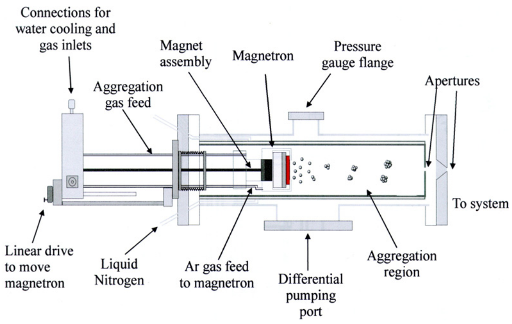
Thesis Outline

The present thesis aims to provide understanding on the applicability of nanoparticles for hydrogen storage. In particular we are interested in Mg nanoparticles, which are known as one of the promising candidates for hydrogen storage. Our main motivation was to analyze the structural details and the changes that can occur within the nanoparticles during hydrogen absorption/desorption. In the course of the investigation we were confronted with the problem associated with the thermal stability of magnesium nanoparticles. A crucial aspect is that size reduction is favoring the evaporation of the Mg, because a higher vapor pressure is associated with smaller nanoparticles. In addition we also discovered how the presence of oxygen and the MgO shell around the Mg core is very crucial for the stability of the Mg nanoparticles. Therefore, here we made an effort to study and discuss in detail these limitations in order to benefit the use of magnesium nanoparticles for hydrogen storage. As a result a number of different strategies have been suggested that can help to alleviate the thermal stability limitations of Mg nanoparticles.

Chapter 1. Introduction

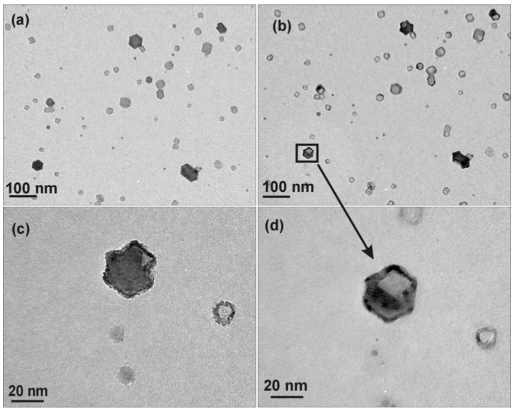
In this first chapter, an introduction about the hydrogen and its importance as an energy carrier, why Magnesium and its nanoparticles are interesting for hydrogen storage and other basic concepts are discussed

Chapter 2. Experimental Procedures



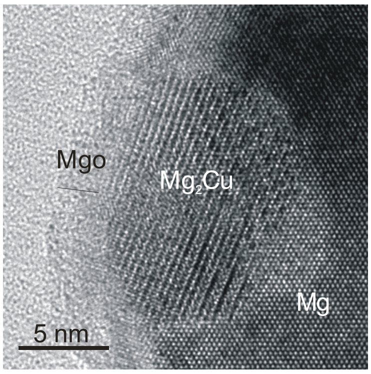
A detail description of nanoparticle deposition system and their characterization using TEM is presented in this chapter.

Chapter 3. Thermal Stability of Gas Phase Magnesium Nanoparticles for Hydrogen Storage.



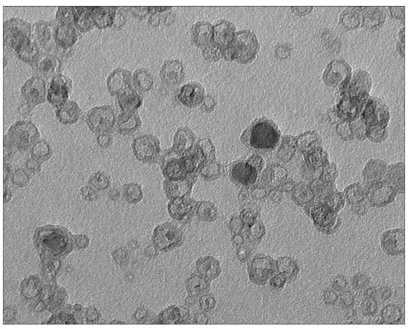
Analysis of the Mg nanoparticles before and after hydrogenation has been discussed in chapter 3, along with the problem associated with the thermal stability of Mg nanoparticles for hydrogen storage.

Chapter 4. Improved Thermal Stability of Gas Phase Mg Nanoparticles for Hydrogen Storage.



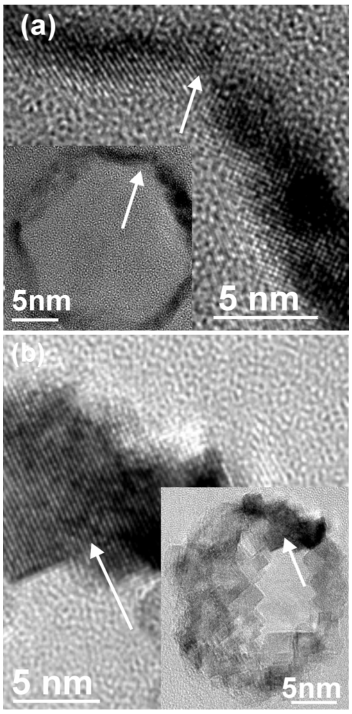
In chapter 4, our focus was to improve the thermal stability of Mg nanoparticles for hydrogen storage. In this work, three ways have been demonstrated which could suppress/prevent the Mg evaporation and increase the thermal stability of Mg nanoparticles.

Chapter 5. Influence of Ti on the formation and stability of gas-phase Mg nanoparticles.



In chapter 5, we show how the oxygen present in the aggregation volume during the production of the nanoparticles can produce stable Mg nanoparticles above a critical size and hollow Mg core below this critical size due to the Kirkindall effect associated with both evaporation and oxidation.

Chapter 6. Formation of Hollow MgO Nanoshells: Formation and Stability.



In chapter 6, we describe the formation and stability of hollow MgO nanoshells. In fact we show how an evaporation of Mg can be used in principle for the formation of hollow MgO nanoshells. The stability of these nanoshells under electron beam exposure and during prolonged storage at room temperatures is discussed.